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A LABORATORY EVALUATION OF PRIMITIVE COTTON (*GOSSYPIUM HIRSUTUM* L.) RACES FOR PINK BOLLWORM RESISTANCE

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A LABORATORY EVALUATION OF PRIMITIVE COTTON (*Gossypium hirsutum* L.) RACES FOR PINK BOLLWORM RESISTANCE

By R. L. Wilson and F. D. Wilson[1]

INTRODUCTION

The pink bollworm, *Pectinophora gossypiella* (Saunders), is a major insect pest in many cotton-growing areas in the world. In the United States, it is the main pest of cotton in the desert valleys of southern California and Arizona.

For adequate chemical control, cotton fields should be sprayed regularly (every 5 to 7 days) because the first instar larvae enter the cotton boll soon after hatching and are thus protected from most pesticides. Host plant resistance offers an alternative to intensive chemical control by reducing both the cost of control and environmental contamination.

Our search for biochemical resistance in cotton to pink bollworm has been centered in the primitive race stocks of *Gossypium hirsutum* L. maintained at College Station, Tex., under the auspices of the Agricultural Research Service - Cooperative State Research Service Regional Research Project S-77.[2] Chances of finding resistance in these cottons is considered favorable because they are genetically diverse. Use of these stocks in breeding programs will also broaden the germplasm base of cotton cultivars, a desirable objective.[3] [4]

Screening plants for resistance to insects in the field is superior to laboratory screening in the sense that insects can select and develop on live plants. However, field screening in Arizona was not possible because many of the race stocks flower only during short days. Therefore, we harvested green bolls from race stocks grown in Mexico for screening cottons for resistance to other insects, and evaluated their resistance the pink bollworm by incorporating the components of the bolls into a laboratory diet as described by Wilson and Wilson.[5]

Resistance to pink bollworm might also signal resistance to other cotton insects. Therefore, this report may benefit researchers investigating resistance in cotton to several other pests. A list of the race stocks that we tested on carpel wall and boll content diets from 1972 to 1975 is given in this report, along with data on the race stocks that we selected for resistance. In addition, data are presented on several race stocks that are presumably susceptible to pink bollworm, because insects on diets prepared from their bolls grew as well as those reared on the regular artificial diet.

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[2] Anonymous. The regional collection of *Gossypium* germplasm. U.S. Dept. Agr., Agr. Res. Serv. ARS H-2, 105 pp. 1974.

[3] Anonymous. Genetic vulnerability of major crops. National Academy of Science. Washington, D.C. 307 pp. 1972.

[4] Sprague, G. F., ed. Recommended actions and policies for minimizing the genetic vulnerability of our major crops. A special report by an ad hoc subcommittee of the Agricultural Research Policy Advisory Committee. U.S. Dept. Agr., Washington, D. C. 34 pp. 1973.

[5] Wilson, R. L., and Wilson, F. D. Laboratory diets for screening cotton for resistance to pink bollworm. Cotton Growing Rev. 51: 302-308. 1974.

MATERIALS AND METHODS

The race stocks were grown by M. J. Lukefahr, ARS, Brownsville, Tex., at two locations in Mexico, as follows: (1) Instituto de Investigaciones Agricolas, Centro de Investigaciones Agricolas de Sureste, Campo Cotaxtla, Veracruz, in 1972-73; and (2) private land near San Rafael, Veracruz, in 1973-74. At the two locations, an upland check line was grown, M-8, a doubled haploid recovered from 'Deltapine 14' by J. R. Meyer.

We harvested green bolls 2 to 3 weeks old, placed them in insulated containers with dry ice, and shipped them to the Western Cotton Research Laboratory, Phoenix, Ariz. Bolls were separated into components of carpel wall and interior boll contents. These materials were lyophilized and later incorporated into diets for rearing the pink bollworm. The growth and development of larvae and pupae were monitored for each diet. Methods are detailed in Wilson and Wilson.[6]

RESULTS AND DISCUSSION

Table 1[7] lists the Texas race stocks that have been bioassayed in our laboratory. We have tested 304 lines using the carpel wall diet and 258 lines using the boll content diets.

The 42 lines listed in table 2 were selected because they had a significant detrimental effect on larval growth and development on carpel wall diets. The values given for the regular wheat germ diet and the M-8 field check are averages calculated from all the tests run during the 3-year evaluation.

Table 3 lists the 23 lines selected for adversely affecting larval growth and development on boll content diets. The values for the regular diet and the M-8 field check diet are also 3-year averages.

Table 4 lists diets from cottons considered susceptible to pink bollworms because growth and development of the insect did not vary significantly from that on the regular pink bollworm diet.

Several of the race stocks selected for resistance to pink bollworms are day neutral. These stocks and their hybrids with cultivars have been or will be field tested in Arizona where natural pink bollworm populations occur. Photoperiodic lines and their hybrids with cultivars will be tested during the shorter days of the winter in Puerto Rico, a tropical location that harbors natural populations of pink bollworms. Finally, both day neutral and photoperiodic lines and hybrids will be evaluated in the greenhouse by hand-infesting bolls and evaluating the larvae for growth and development.

Two lines, T-25 and T-336, have been selected from both carpel wall and boll content diet tests.

CONCLUSIONS

Documentation of our data will allow other workers to compare their results and perhaps to make some generalizations, because many race stocks have been screened for resistance to several cotton insects. These data may also help others save time by investigating our resistant lines first.

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[6] See footnote 5.

[7] All tables appear at the end of the report.

The immediate value of our screening procedure is that we have reduced considerably the number of cottons to consider in breeding for resistance to pink bollworm. For a time, we can concentrate on the selected lines and attempt to discover the mechanisms of resistance, whether resistance can be transferred into agronomically acceptable varieties, and whether more than one type of resistance can be combined into a common background.

The ultimate value of this screening method will not be known until advanced lines can be tested against the pink bollworm under natural field conditions.

Table 1.--*List of Texas race stocks that have been tested for pink bollworm resistance through a laboratory bioassay utilizing either lyophilized carpel walls or boll contents, 1972-75*

Texas No.	Carpel wall	Boll content	Texas No.	Carpel wall	Boll content	Texas No.	Carpel wall	Boll content
2	X		61	X	X	118	X	X
6	X	X	62	X	X	119	X	X
7	X	X	63	X	X	123	X	
8	X	X	64	X	X	128	X	X
9	X		65	X	X	129	X	X
11	X		67	X	X	140	X	X
16	X	X	68	X	X	141	X	X
17	X	X	71	X	X	142	X	X
21	X	X	72	X	X	143	X	X
22	X	X	73	X	X	144	X	X
25	X	X	74	X	X	145	X	X
27	X	X	77	X	X	146	X	X
30	X		78	X	X	152	X	X
31	X	X	79	X	X	153	X	X
32	X	X	83	X	X	155	X	
33	X	X	86	X	X	160	X	X
35	X	X	89	X	X	161	X	X
36	X	X	93	X	X	163	X	X
37		X	96	X	X	164	X	X
38		X	100	X	X	165	X	X
39	X	X	101	X	X	167	X	X
40	X	X	102	X	X	169	X	X
43	X	X	103	X		171	X	X
44	X	X	104	X	X	175	X	
48	X	X	105	X	X	176	X	
49	X	X	107	X	X	179	X	
50	X		108	X	X	181	X	
51	X		109	X	X	183	X	X
53	X	X	111		X	184	X	
55	X	X	112	X	X	185	X	
56	X	X	113	X	X	187	X	X
57	X	X	114	X	X	188	X	X
58		X	116	X		192	X	X

Table 1.--*List of Texas race stocks that have been tested for pink bollworm resistance through a laboratory bioassay utilizing either lyophilized carpel walls or boll contents, 1972-75--Continued*

Texas No.	Carpel wall	Boll content	Texas No.	Carpel wall	Boll content	Texas No.	Carpel wall	Boll content
196	X	X	294	X	X	473	X	X
197	X	X	295	X		479	X	X
198	X		297	X		490	X	
199	X	X	301	X	X	492	X	
200	X	X	304	X	X	497	X	X
202	X		306	X	X	498	X	X
203	X	X	308	X	X	499	X	
206	X	X	311	X	X	500	X	
207	X		312	X	X	503	X	X
213	X	X	314	X	X	542	X	
214	X	X	316	X		570	X	X
216	X	X	318	X		592		X
217	X	X	322	X	X	596	X	X
218	X	X	323	X	X	597	X	X
219	X	X	324	X	X	600		X
220	X	X	325	X		608	X	X
221	X	X	326	X	X	609	X	X
222	X		327	X		610	X	X
225	X		330	X	X	611	X	X
226	X	X	333	X	X	612	X	X
227	X		335	X	X	615	X	X
228	X	X	336	X	X	616	X	X
229	X		337	X	X	619	X	X
231	X		339	X	X	621	X	X
232	X	X	340	X		622	X	X
233	X	X	342	X	X	625	X	X
236	X	X	344	X	X	633	X	X
238	X	X	347	X	X	634	X	X
239	X	X	375	X	X	636	X	X
240	X		377		X	637	X	X
242	X	X	396	X	X	639	X	X
244	X	X	399	X	X	641	X	X
245	X		401		X	642	X	X
247	X		406	X	X	643	X	X
251	X	X	408	X	X	644	X	X
254	X		409	X	X	645	X	
257	X	X	419	X		646	X	X
259	X	X	458	X	X	647	X	X
260	X	X	459	X	X	649	X	X
261	X		460	X	X	650	X	X
265	X	X	461	X	X	655	X	X
266	X	X	462	X	X	657	X	
267		X	463	X	X	658	X	
293	X	X	469	X	X	665		X

Table 1.--*List of Texas race stocks that have been tested for pink bollworm resistance through a laboratory bioassay utilizing either lyophilized carpel walls or boll contents, 1972-75--Continued*

Texas No.	Carpel wall	Boll content	Texas No.	Carpel wall	Boll content	Texas No.	Carpel wall	Boll content
668	X	X	763	X	X	1105	X	X
674	X		764	X	X	1125	X	X
675	X	X	765	X		1131	X	X
677	X	X	766	X	X	1134	X	X
678	X	X	769	X	X	1147	X	
679	X		770	X	X	1148	X	X
681	X	X	771	X		1149	X	
682	X	X	775	X	X	1150		X
683	X	X	786	X		1151	X	X
684	X	X	787	X		1155	X	X
685		X	790	X	X	1156	X	
686	X	X	805	X	X	1157		X
687	X	X	937	X	X	1158	X	X
695	X	X	938	X		1159	X	X
701	X	X	941	X	X	1161	X	X
703	X	X	947	X	X	1164	X	
705	X	X	950	X	X	1166	X	X
707	X	X	951	X		1167	X	X
709	X	X	952	X	X	1174		X
711	X	X	954	X	X	1175	X	X
712	X	X	955	X		1176	X	X
720	X	X	960	X	X	1177	X	X
725	X	X	986	X		1179		X
729	X		1045		X	1180	X	X
743	X	X	1048	X	X	1182	X	X
754	X		1053	X	X	1183	X	
755	X	X	1054	X	X	1187	X	X
756	X	X	1055	X	X	1188	X	X
759	X		1057	X	X	1189	X	X
760	X	X	1067	X	X	1196		X

Table 2.—*Larval development time, percent pupation, pupal weight, percent pupae to adult, and percent larvae to adult of pink bollworms placed on modified laboratory diets incorporating lyophilized carpel walls from 42 selected race stocks*[1]

Diet	Larval development time	Pupation	Pupal weight	Pupae to adult	Larvae to adult
	Days	*Percent*	*Milligrams*	*Percent*	*Percent*
Regular	12.80	81.6	22.30	93.60	76.0
M-8 (check)	24.80	58.2	12.60	26.70	15.0
T-25	27.31	15.0	11.30	13.33	2.0
T-31	34.40	24.0	10.00	25.00	6.0
T-39	38.40	10.0	7.70	20.00	2.0
T-53	29.00	1.0	15.70	100.00	1.0
T-55	32.60	55.0	10.00	11.20	6.0
T-62	31.13	48.0	11.50	12.50	6.0
T-72	33.00	1.0	18.70	0	0
T-78	36.70	10.0	5.90	0	0
T-101	20.83	78.0	12.74	34.10	10.0
T-103	29.36	53.0	12.90	18.83	10.0
T-164	30.80	71.0	9.40	8.10	6.0
T-181	36.50	10.0	8.70	25.00	2.0
T-185	38.07	20.0	7.76	0	0
T-203	---	0	---	---	0
T-206	35.70	60.0	9.30	10.50	6.0
T-207	37.00	11.0	7.00	0	0
T-216	---	0	---	---	0
T-226	36.25	12.0	9.42	8.33	1.0
T-245	27.50	5.0	13.50	40.00	2.0
T-247	26.56	35.0	13.49	50.30	18.0
T-316	38.20	10.0	8.90	20.00	2.0
T-335	30.00	2.0	9.00	0	0
T-336	---	0	---	---	0
T-339	---	0	---	---	0
T-342	25.00	2.0	17.25	100.00	2.0

See footnote at end of table.

Table 2.--*Larval development time, percent pupation, pupal weight, percent pupae to adult, and percent larvae to adult of pink bollworms placed on modified laboratory diets incorporating lyophilized carpel walls from 42 selected race stocks*[1]*--Continued*

Diet	Larval development time	Pupation	Pupal weight	Pupae to adult	Larvae to adult
	Days	*Percent*	*Milligrams*	*Percent*	*Percent*
T-469	37.86	23.0	7.72	4.35	1.0
T-616	26.20	46.0	9.30	0	0
T-639	28.10	64.0	11.40	8.00	5.0
T-646	35.60	37.0	8.40	6.10	2.0
T-657	35.60	22.0	9.20	8.30	2.0
T-658	36.02	29.0	9.05	0	0
T-668	38.60	56.0	7.00	0	0
T-682	31.40	60.0	11.00	7.50	4.0
T-703	26.40	73.0	12.40	19.10	14.0
T-705	27.20	59.0	9.80	0	0
T-711	25.30	33.0	8.33	1.80	1.0
T-763	33.87	47.0	10.51	10.64	5.0
T-955	38.47	13.0	7.51	7.69	1.0
T-960	---	0	---	---	0
T-1048	18.62	19.0	16.10	31.58	6.0
T-1177	---	0	---	---	0
T-1182	---	0	---	---	0

---

[1] Each diet was replicated 4 times.

Table 3.--*Larval development time, percent pupation, pupal weight, percent pupae to adult, and percent larvae to adult of pink bollworms placed on modified laboratory diets incorporating lyophilized boll contents from 23 selected race stocks*[1]

Diet	Larval development time	Pupation	Pupal weight	Pupae to adult	Larvae to adult
	Days	*Percent*	*Milligrams*	*Percent*	*Percent*
Regular	12.4	80.2	21.8	93.8	75.2
M-8	19.5	38.4	14.4	47.5	18.2
T-21	19.2	71.0	11.9	15.0	11.0
T-25	17.2	35.0	14.1	40.4	14.0
T-40	24.7	48.0	12.5	63.5	30.0
T-43	18.3	76.0	12.0	30.9	23.0
T-65	---	0	---	---	0
T-93	20.4	72.0	10.1	10.0	7.0
T-102	17.1	71.0	13.1	18.3	13.0
T-169	18.0	35.0	12.5	17.1	6.0
T-220	28.8	35.0	8.9	9.8	3.0
T-232	28.9	35.0	9.9	33.9	12.0
T-293	20.5	57.0	11.5	14.0	8.0
T-306	18.7	25.0	14.7	58.0	14.0
T-336	17.2	11.0	17.3	66.9	7.0
T-596	24.2	32.0	16.4	86.0	27.0
T-622	19.8	17.0	15.0	82.3	14.0
T-712	22.1	27.0	8.3	3.7	1.0
T-764	21.2	53.0	10.3	15.1	8.0
T-775	18.8	57.0	14.3	34.3	19.0
T-937	24.2	38.0	10.2	37.0	14.0
T-1053	16.6	30.0	15.6	35.0	10.0
T-1125	18.3	42.0	12.7	21.5	9.0
T-1158	18.5	28.0	15.3	54.7	15.0
T-1180	18.0	69.0	12.9	21.6	15.0

[1] Each diet was replicated 4 times.

Table 4.--*Larval development time, percent pupation, pupal weight, percent pupae to adult, and percent larvae to adult of pink bollworms placed on modified laboratory diets incorporating lyophilized carpel wall from Texas race stocks not significantly different from the regular diet*[1] [2]

Diet	Larval development time	Pupation	Pupal weight	Pupae to adult	Larvae to adult
	Days	*Percent*	*Milligrams*	*Percent*	*Percent*
Regular	12.8	81.6	22.3	93.6	76.4
T-6	14.1	77.0	19.9	87.0	67.0
T-11	11.9	71.0	24.1	98.8	70.0
T-11 (BC)	15.2	77.0	19.7	75.3	58.0
T-187	16.2	84.0	21.7	94.2	79.0
T-254	12.1	87.6	24.2	95.3	83.0
T-265	12.6	82.0	24.4	96.1	79.0
T-266	14.4	81.0	25.2	91.2	74.0
T-460	12.8	66.0	23.5	100.0	66.0
T-756	20.1	66.0	22.3	80.3	53.0
T-767	14.6	70.0	23.2	97.1	68.0
T-790	12.5	77.0	24.6	97.4	75.0
T-947	13.4	83.0	24.8	93.0	77.0
T-954	13.4	80.0	19.3	92.9	74.0
T-1006	16.8	68.0	18.8	78.2	53.0
T-1176 (BC)	13.3	66.0	19.5	86.1	57.0
T-1188	14.4	67.0	20.6	91.3	61.0

[1] Each diet was replicated 4 times.

[2] Cotton followed by (BC) indicates lyophilized boll content used in diet.

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